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Light and Lighting

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Edited by J. STEWART DOW

Telephone: ABBey 5215.

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Principal Contents:

The Quality of Lighting

ELSEWHERE will be found the new Draft Regulations for Industrial Lighting (p.184). Their main feature is the adoption of higher values of illumination as foreshadowed in the "Fifth Report," including 6 foot-candles for general lighting (as compared with 1 foot-candle recommended only about two years ago!). No specific *regulations* are made in regard to quality of lighting, except those concerned with glare and shadows (the latter very general in scope); one regulation proposed in the "Fifth Report," relating to the use of light colours for walls and ceilings, has dropped out, though useful *recommendations* on this and other points are made.

It is of course very much easier to specify quantity than quality. Yet, as Mr. Weston and Mr. Maxted pointed out in recent papers before the I.E.S., the latter is as important as the former, sometimes even more so. For almost every task in industry there are special considerations to be met in regard to colour, degree of diffusion, absence of glare, emphasis, mode of direction of light.

Moreover, advances in quantity often necessitate changes in quality—as is illustrated by the trend towards indirect and louvred lighting in the U.S.A. and the extending use of fittings of extensive area and low brightness.

For the moment ideals may have to give place to speed—to secure the higher standards of illumination in so many factories must mean improvisation and adaptation of existing installations. But let us still keep our eyes on the distant goal.

In the future *fitness* of the mode of lighting for any particular task, and its influence on the comfort, spirits, and general welfare of the worker, may well come to weigh more heavily than at present. Treatment of the surroundings—even interior decoration—may be associated as closely with the choice and location of fittings, as in other fields of illumination. "Industrial Lighting," in short, may no longer be isolated from other forms of lighting, but regarded as subject to the same balance between utilitarian aims and amenity value.

Headlights and Sidelights

According to the latest information received motorists are to have one concession during the winter—permission to use their masked headlights after midnight during an "Alert," provided they are extinguished when warning is given of the presence of aircraft overhead. Coupled with this, however, is the condition that the exposed area of sidelights must be reduced to the size of a half-penny, the light being invisible at 300 yards, though clearly seen at 30 yards—a condition surely difficult to fulfil! It is common knowledge that the sidelamps of many cars have become unduly bright, much brighter doubtless than the regulations intended. Their effect has been such as to exceed by far any possible brightness arising from war time street lighting. It would appear, however, that the Authorities have not been following very scientific or logical methods in dealing with this difficulty. If a limitation is to be set to candlepower or brightness this could be achieved much more safely by the use of a simple photometer (such as that described in our last issue*), than by rules implying visibility at some stated distance, and invisibility (or inconspicuousness) at a greater one. It seems to have escaped notice that the danger from sidelamps arises much more from the fact that the light is unchecked in regard to direction than from undue brilliancy. It is doubtless inexpedient that side lamps should be restricted in the same degree as headlights, but a simple form of screen limiting the light upwards and yet not impairing appreciably the service of the lamp could be readily contrived, which would minimise the danger of revealing the existence of roads to aerial observation.

Lights Inside Public Vehicles

The original regulations relating to the interior lighting of public vehicles quickly proved unworkable, and a substantial increase in the permissible illumination was included in the later edition of the Lighting Restrictions Order. Bus-conductors, have, however, been recently agitating for a higher standard —contending that the task of collecting fares and issuing tickets is too difficult under present conditions. If the overcrowding characteristic of rush hours at the present moment is to continue during twilight hours in winter this will accentuate difficulties. Present methods of lighting are based mainly on severe directional restriction of light, the cut-off ensuring that little light strays outside the vehicle. But this method is the worst possible in a crowded bus, where diffusion of light from the ceiling is desirable. This seems to be one more case of distinguishing between an "Alert" and "Aircraft Overhead," which may ultimately affect many of our present lighting restrictions.

* "Photometer for Testing Motor Car Headlights," "Light and Lighting," p. 164, Oct., 1940.

National Service by the Australian I.E.S.

Australia is showing itself alert to the problems with which we in this country have been grappling in connection with A.R.P. lighting. In the Transactons of the Illuminating Engineering Society of Australia (Victoria) reference was recently made to the useful work undertaken by the British I.E.S. in this direction. In Australia the Society has already placed its technical service at the disposal of the State Emergency Council. A committee has now submitted specific suggestions as to A.R.P. service to be rendered on lines similar to that followed by the I.E.S. in Great Britain. These suggestions are briefly as follows:—

(1) Preparation or adaptation of the many A.R.P. Specifications dealing with Lighting Restrictions.

(2) Preparation or adaptation of instructions to be issued to industrial and commercial undertakings, or householders as to methods to be followed in complying with the Lighting Restriction Regulations.

(3) Instructions of the Police, Air-raid Wardens, or other persons likely to be entrusted with the enforcement of the Lighting Restrictions Regulations as to the interpretation of the many technical provisions of the relevant Specifications.

(4) The training of a group of twenty or more of the Society's members in every technical and practical aspect of Lighting Restriction problems in industry. It is suggested that the services of this group may, in the event of a sudden emergency, be requisitioned by the authorities to assist industry to overcome the great difficulties of rapidly complying with Lighting Restriction Regulations without restricting production.

Members of the Society are being invited to suggest other avenues of national service.

Camouflage

The recent report of a Select Committee on the above subject shows how varied are the views held in regard to methods of camouflage, and how widely practice often seems to depart from theory. New conditions of warfare no doubt lead to modification of previous practice. It has been stated, for example, that the application of dazzle painting to ships is no longer worth while, owing to observation by aircraft overhead. Changes in conditions of warfare may diminish the value of certain forms of camouflage. Yet the fundamental principles which depend on skilful blending of contrast and colour remain unchanged, and ineffectiveness may often be due to neglect of these principles or confusion of thought in their application. One can hardly doubt that camouflage has still great possibilities, especially, perhaps, in fields that have as yet only been very imperfectly explored, such as protection against night attacks.

Light Up in the Afternoon?

We are now approaching the shortest days of winter. Journeys to London's suburbs, already sufficiently complicated, are likely to become more so, and in other cities similar difficulties, though possibly less acute, will probably be felt. The Government decision that the normal closing hour for shops will be 6 p.m. (with extensions to 7.30 on one day a week) is therefore a natural one. It is, indeed, probable that those who can do so will endeavour to get their shopping done considerably earlier than this. There are signs that the real shopping period will shift backwards into the afternoon, before the black-out comes into operation, and there is already a tendency for windows to be lighted up comparatively early and well before dusk. If there were any serious fuel shortage, such as to make economy in electricity of vital importance, one would not, of course, desire to encourage this practice, but apparently this is not the case. Those in the lighting industry might therefore well encourage merchants to furnish a little gaiety in the streets whilst some daylight still prevails. After all, there are not many afternoons in the British mid-winter when artificial lighting of windows, if carried out on approved principles, is not of some benefit to the public besides the owners of shops. In view of the fact that the gloom of the black-out sets in so early, people may feel that a little attempt to produce more cheerful conditions somewhat earlier is fully justified. (We understand, by the way, that the prohibition of window-display lighting during the black-out does not extend to the simple signs which merely indicate the name and purpose of a shop and the fact that it is open to the public, provided the brightness is not excessive and they are extinguished when a warning of a raid is received.)

Street Lighting in Western Australia

Although we in this country are precluded by the black-out from experiencing street lighting as we used to know it, it is pleasant to be able to record developments overseas, and gratifying to be reminded that we are still able to export the appliances

serving this purpose. The accompanying picture shows a night impression of the Stirling Highway in Western Australia, which is evidently being lighted in accordance with the best modern methods. On this highway Benjamin "Rodalux" units have recently been installed. The units are mounted on the trolley wire posts at intervals of 200 ft. Similar lighting of a somewhat lower intensity is being introduced on adjacent side roads.

An Automatic Light Lock

We illustrate below an ingenious model of a simple form of light lock which appears to be doing good service in Scotland. We are indebted to Mr. M. W. Hime, District Engineer to the E.L.M.A. Lighting Service Bureau in Scotland, for the particulars of this model, which has been developed at the Bureau under his charge. The model is merely a nine-inch cube and the pictures are self explanatory. As the door opens the curtain closes and automatically forms a light-trap. An automatic closer on the door itself ensures complete automatic operation of both door and lock. The model is naturally of a somewhat simpler character than the full-size working arrangement, for which proper standard curtain-runners and rails are used. Concealed in the folds of the curtain is a one-inch batten to take the weight of the farthermost overhang point of the plywood roof. From the black-out point of view it is expedient to run a two-inch or three-inch webbing down the jamb of the door at the hinges side, and in actual practice a pelmet would also be fitted. Such a light lock can be produced for £2 to £3 for a 3 ft. 6 in. door, and the pull required to operate and work the curtain does not exceed 3 lb. The arrangement seems a particularly useful one for small shops and the like, where space is limited.

Another useful demonstration device developed at the Bureau is a 12 in. cube box in which the 2 and 6 ft.c. mentioned in the Fifth Report on Factory Lighting and the service value of 15 ft.c. can be demonstrated. Provision has also been made to produce standard A.R.P. lighting values, e.g., 0.002, 0.2, and 0.2 ft.c.

Fig. 1. Model packed up in box.

Fig. 2. The outer door closed: curtain only partially drawn at side, admitting to interior of shop.

Fig. 3. The outer door open: the curtain at the side is now completely drawn, so that no light from the interior of the shop can escape.

Industrial Lighting in War Time

(Summary of a paper read by Mr. H. C. Weston before the Illuminating Engineering Society on October 22nd)

There was a good attendance to hear Mr. Weston's paper on the above subject on October 22. As in the case of the previous meeting the time of assembly—2.30 p.m.—did not prove too great a drawback, and again, fortunately, air raid warnings did not materially interfere with the course of events.

This was the first gathering presided over by the new President, Professor J. T. MacGregor Morris, who, in winding up the meeting, endorsed the remark made by the author in regard to the great opportunity now offered to illuminating engineers to render national service in the improvement of factory lighting.

Mr. Garrett, H.M. Chief Inspector of Factories, was himself unable to attend the meeting as he had hoped, but his deputy, Mr. Chasteney, of the Home Office Factory Department, opened the discussion, and Sir Duncan Wilson, the Chairman of the Departmental Committee on Factory Lighting, wound up the debate.

Effects of Lighting Restrictions Order on Interior of Factories.

In the introduction to his paper Mr. Weston pointed out the influence which the Lighting Restrictions Order had exerted on the interior lighting of factories; for example, in causing total or restricted admission of natural light during the day, and modifications in existing lighting arrangements. The only practical "black-out" applicable to many factories consisted in literally blacking out every window. Undesirable consequences immediately ensued, notably, the impairing of ventilation and the production of tropical temperatures, occasioning considerable discomfort to workers.

The total exclusion of daylight amounted to a change from day to night work for many workers. Moreover, the artificial lighting provided in a number of factories was, and is still, physiologically inadequate and unsuitable for full-time work. It is not surprising that a number of complaints arose of soreness and inflammation of the eyes, and of headaches at the end of the day's work.

On the other hand, few complaints have been made by persons employed in factories which, by modern standards, are well lighted. No evidence is forthcoming that artificial lighting is, in these circumstances, a factor likely to prejudice health even when it has to be used continuously throughout long working days. In many factories the provision made for artificial lighting has been definitely influenced by the fact that its use is normally confined to short periods not exceeding 15 per cent. of the total hours of work. Accordingly, no factor of safety has been allowed, with unfortunate results in present circumstances.

At one large textile factory, where daylight has been entirely excluded, efficiency is reported to have dropped by 5 to 7½ per cent., and considerable unrest has occurred in spite of a compensatory wage increase of 7½ per cent. Other cases of diminished production and nervous irritability among workers attributed to indifferent or bad lighting have been reported.

War Productivity and Factory Lighting.

The recent great response of industry to the national need does not vindicate the status quo in lighting. During the first six months of the war visits to factories led to the conclusion that, often, little unusual effort was being attempted.

This normal rate of work is kept fairly well below the upper limit of real capacity. There is, therefore, always the possibility of reaching higher, often quite unexpected, levels of personal efficiency in response to a powerful psychological stimulus.

The present maximum effort, with existing conditions of lighting, is, however, unlikely to be long sustained, for this is only possible for "normal," not maximum, effort. But better lighting may bring the effort required for the same, or even greater, productivity within the limits of normality.

Most of the research directed—during the inter-war years—to establishing the best conditions of industrial lighting has shown the need for something better than existing average practice. Conditions of lighting tried experimentally have been shown to evoke greater output, not at the expense of human energy reserves, but as a new normal level, not less, but perhaps more, within the new limit of capacity engendered.

Unprecedented demands must be made upon the productive capacity of workers in essential industries during war, especially if the time available for production is curtailed by frequent threats of air attack. Yet, though artificial lighting has to be used much more than in normal times, it has not, in general, been planned to give workers the fullest possible help in meeting these demands.

In some cases bad lighting has even been substituted for good—e.g., the replacing of general lighting by local lighting in order to prevent trouble due to imperfectly screened windows, or in response to appeals for economy in consumption of gas or electricity.

The pace of war cannot be kept with any brake on industry. Good lighting is essential not only for speedy production but in order to maintain a standard of accuracy and quality more rigorous in war than in peace.

Changes in task—not merely from the familiar to the unfamiliar, but also from fine to finer—also accentuate the importance of good lighting; and likewise changes in personnel, such as the introduction of semi-skilled workers or women unaccustomed to factory life.

Limitations of Lighting.

The illuminating engineer should, however, recognise that lighting has its limitations as a tool of industry. Some of the finest and most exacting tasks in the production of munitions give rise to eyestrain, however good the lighting may be, unless other aids to vision are used. Increasing illumination does not, of course, magnify fine detail, though, by increasing visual acuity, it has an equivalent effect. But even with illuminations of the order of 100 ft.c. the apparent size of the detail has sometimes to be magnified by reducing the distance between the work and the eyes as much as possible. For very fine work it is not enough to provide excellent lighting. Some optical aid should also be used, preferably in the form of special spectacles. A useful rule to bear in mind is that if, when lighting is provided according to the I.E.S. Code, workers find it necessary habitually to bring the eyes nearer than ten inches from their work the use of special spectacles should be suggested.

Daylight.

The experience of the past year emphasised the familiar fact that natural lighting is universally preferred to any artificial lighting commonly used in factories. Many persons have long been accustomed to work by day in artificial light. Most, if not all, would much rather have natural lighting, but have long since accepted conditions they cannot change. But, for many more, the war has changed the natural

and expected order of things, by which there is natural lighting by day and artificial lighting only by night. The admission of some daylight seems to be generally desired. This gives a visible assurance of daytime which the twelve-hour clock does not give. Such "daylight tokens" should not be glare sources. Where artificial lighting is poor and the general interior brightness low, a small unobscured window near the normal line of vision is as undesirable as any other light source of relatively high brightness. Care needs to be taken in selecting windows and in controlling their brightness by the use of diffusing media if necessary.

Much factory work can be done satisfactorily without artificial light if the unobscured window to floor area is in the ratio of about 1 to 8. A ratio of 1 to 12, or even 1 to 20, may suffice for roof-lighted factories. In modern factories of this type the ratio of window to floor area is often about 1 to 3, so that from two-thirds to three-quarters of the total window area can be permanently obscured without rendering natural lighting inadequate.

As far as possible, of course, the windows equipped with removable shutters should be selected to permit the best distribution of daylight. Unless there is good reason to the contrary, as where benches requiring good daylight are arranged against the walls, the upper rather than the lower part of wall windows should be uncovered.

Interior Appearance and Present Methods of Lighting.

The effect of obscuring windows by means of black paint is as well described as "blacking-in" as "blacking-out." The general appearance of the factory interior is depreciated, and a valuable amount of light which might be reflected into the shop is lost. Accordingly the interior surface of glazing is being whitened to an increasing extent.

Wherever the walls, floor, and roof of factories are clean and light in colour, and general lighting is installed, the appearance of the factory is greatly enhanced. Unfortunately, there are many factories where these conditions are not found. One of the most noticeable features is the black top above the light sources, against which the latter present a high brightness contrast. With direct general lighting in a large workshop a forest of bright patches is seen set in a dark "sky," so unlike anything natural that to become oblivious of the means of lighting is impossible. One is constantly reminded that the lighting is artificial and very different from the natural lighting it replaces. This defect is not so noticeable where fittings with partly open tops are used, though it is not absent. Further improvement can be effected, without adding greatly to the total lighting load, by arranging a few units to illuminate the roof.

As yet, however, factory lighting has not been planned with sufficient regard for the simulation of natural conditions, even in respect of brightness distribution in the whole visual field. This point has gained importance with the extensive substitution of artificial for natural factory lighting during the war, and it is a truism to say that the less any substitute differs from a real thing that is good the more readily is it accepted and desire for the real thing forgotten. It is a sound principle of good lighting that it should facilitate seeing without being ostentatious.

Improvement of Factory Lighting.

Drastic alterations, or completely new installations, will be needed in some factories to comply with the recent recommendations of the Factory Lighting Committee in their Fifth Report. In others, one must make the best of existing equipment, and by the more or less liberal use of paint and limewash.

The most important new recommendation made in the Fifth Report* specifies an illumination of not less than 6 ft.c. at working level, or at 3 ft. above floor level, in all interior parts of factories where persons are regularly employed, without prejudice to any additional illumination which the nature of the work may require.

This recommendation was intended to secure, firstly, that the illumination in workshops should be good enough to enable most ordinary work to be done comfortably and efficiently, and, secondly, a reasonable general level of brightness.

The second of these considerations prompted also the second recommendation, that throughout the interior parts of factories where persons are regularly employed, parts of walls, partitions, ceilings, tops of rooms, inside of windows where daylight is obscured and, as far as practicable, other structural fixtures which are less than 20 ft. above floor level shall be maintained light in colour.†

The only exception to the first recommendation (except for certain scheduled processes) is made in the case of workshops in which the light sources have necessarily to be mounted more than 25 ft. above the floor, or where the structure prevents the uniform provision of illumination to the 6 ft.c. level. In such cases the illumination is not to be less than 2 ft.c., and not less than 6 ft.c. where actual work is being done. The illumination is to be measured in the horizontal plane at a level of 3 ft. from the floor.

Thus, for the first time, a minimum illumination is prescribed which is high enough for tasks included in categories 6 and 7 of the I.E.S. Code, as well as for some tasks covered by category 5. This is a big step forward and, taken in conjunction with other recommendations in the Fourth and Fifth Reports, clearly shows the Departmental Committee's recognition both of the psychological or "feeling-tone" importance of lighting and its importance as an objective factor in relation to industrial efficiency, as well as to health and safety.

Under the Ministry of Supply Act emergency powers exist in virtue of which the Minister can require good lighting in vital war factories. This he has already done, and vital factories under the control of the Ministry, and of the Ministry of Aircraft Production, and the Admiralty, have been instructed to bring their lighting into line with I.E.S. recommendations.

It is clearly important that the necessary improvements in lighting shall be effected as soon as possible, and that competent advice and assistance shall be made available. To provide, on a national basis, the necessary advisory and planning service the co-operation of the lighting industry is essential. Accordingly the electrical section of the industry has organised such a service with the approval of the Ministries concerned with supply and the Ministry of Labour and National Service. This service operates on a non-commercial basis under the control of a Joint Lighting Committee appointed by the industry, but having an independent chairman in the person of Sir Duncan Wilson. Mr. J. S. Dow and the author are also independent members of this committee. To deal with gas-lighted factories the gas industry has set up a similar committee.

Illuminating engineers have already made important contributions to the solution of war-time problems, notably in respect of A.R.P. lighting. They now have a great opportunity to render national service in the improvement of factory lighting—an opportunity which also involves a great responsibility.

Industrial Lighting Practice—Present and Future.

Though no scientific method of determining the illumination desirable for specific tasks is yet available, the I.E.S. recommended values can be used as

* Summarised in "Light and Lighting," p. 125, No. 8, Vol. XXXIII., Aug., 1940.

† This recommendation does not figure in the Regulations now announced and awaiting ratification (see p. 184). Apparently it proved impracticable to include in the Regulations on Lighting a condition relating to the treatment of walls and interior surfaces.—Ed.

a guide without much fear that too low a standard of practice will be set.

A series of fittings particularly designed for factory lighting is available. These are almost exclusively used in providing installations designated as industrial. What this often amounts to is something rather narrowly utilitarian, which takes less account of amenity, in the full sense of the term, than might be the case. The illuminating engineer cannot always help this. He has difficulties to contend with, not the least of which is the price the user of lighting is prepared to pay.

But it will be a pity if factory lighting is allowed to become too stereotyped and if, for example, a particular solution of the glare problem, such as the cut-off fitting, should be relied on to the exclusion of other possible and more satisfactory solutions, such as low brightness units.

Methods of lighting reserved almost exclusively for other interiors could often be used with advantage in factories and, it is to be hoped, will be more readily applicable in the factories of the near future. Closer co-operation between architects, factory engineers, and lighting specialists should lead to structural design which gives wider scope for the use of different methods of artificial lighting, and in many cases the nature of industrial processes need impose few restrictions on the architect's choice of interior structure. The term "industrial lighting" will have little meaning if development proceeds along these lines.

Lighting, even in factories, serves other ends besides the mere revealing of work and, while this is here its prime function, those who plan it should never forget that only in thought, and not in fact, is the work-man an isolate from the whole-man. It is not meant that the broad humanist outlook here suggested to the illuminating engineer should obscure the narrower functional outlook special requirements demand, but only that both are more compatible than is sometimes realised, and that the black-out seems to have revealed a tendency in current practice for the latter to obscure the former.

Fluorescent Tubular Lamps.

Realisation in practice of factory lighting approaching the humanistic and the mere work-light ideals has become easier by the recent addition of the 80-watt fluorescent tubular lamp, with its extended area, low brightness, and resemblance to daylight.

This lamp, used in simple trough fittings, or bare if necessary, has many applications in the factory.

Its suitability for use in artificial windows, luminous panels, and lay-lights is also evident.

Artificial roof-lights using these lamps have been installed in a blacked-out factory and greatly appreciated by the workers. To provide a given illumination, the cost of an installation of this kind is considerably higher than an installation for ordinary tungsten lighting but, as with other discharge lamp installations, the current operating cost is lower.

It is fortunate that a light source having such desirable characteristics should be available at the present time, even if the necessarily limited supplies must restrict its use to situations where its characteristics are likely to be of special value.

Local Lighting.

Emphasis has been laid chiefly on general lighting in the factory because, though always desirable on both physiological and psychological grounds, it is specially important now.

But, of course, supplementary local lighting is not discounted. It is often essential, even when ample daylight is available for the general illumination of the factory, and in many cases the best installation, from every point of view, is one combining general and local lighting. Low-voltage local lighting should find increasing favour, since it offers considerable scope for the development of properly screened and well-placed built-in units.

For very fine work, adjustability of local lighting units is desirable, not only to permit change of direction of light, but to allow individual choice of illumination level. Widely different illuminations may be required by different individuals to develop the high degree of visual capacity necessary for such work.

Exterior Lighting.

The war has made it impossible to give effect to the recommendation in the Fourth Report of the Factory Lighting Committee concerning the lighting of exterior parts of factory premises. But the police can sanction emergency lighting giving very low illumination (0.002 ft.c.) in certain cases to facilitate access to work places. In any case the street lighting level of 0.0002 ft.c. is permissible for private roads on factory premises. If these illuminations are to be worth having, brightness contrasts over the area lighted should be carefully arranged to make the best use of the available light. Here the illuminating engineer needs also to be, in Dr. Paterson's words, a good "contrast engineer."

Maintenance.

Finally, the importance of maintaining the efficiency of lighting installations in wartime must be stressed. If many installations, when new, had only a low factor of safety for peace production, they will seriously impede the war effort if neglected now. Proper maintenance is, therefore, more important than ever. At the same time the difficulty of securing it has sometimes increased, if only for the reason that installations are in use for twenty-four hours a day. The time required for cleaning is being limited in some factories by equipping existing industrial units with glass visors.

Discussion.

The discussion led to various practical points being raised—some of them revealing limitations to the ideal conditions desired by the illuminating engineer. It was mentioned by Mr. Chasteney, for example, that in the present circumstances workers are often rather reluctant to work under a glass roof, in spite of its value in admitting natural light during the day. There is, therefore, bearing in mind this factor and black-out difficulties, still a tendency towards permanent exclusion of daylight—which makes good artificial lighting all the more essential. Mr. Maxted showed a number of illustrations demonstrating the advantages of using extended sources of low brightness, and mentioned several instances in which quality of light, apart from high intensity, had proved to be of great importance in diminishing eye-strain. Mr. Ackerley, whilst sympathising with the author's ideals, pointed out the impossibility of general adoption of methods utilising the latest fluorescent tubular lamps—unless the war was going to last a great deal longer than most of us hoped! Mr. Daniel emphasised the value of light surfaces in diminishing the gloomy effect of factories, and Mr. Iliffe pointed out that little had been said on one very important point—the problem of meeting the new requirements by improvisation of existing installations. Mr. Cunnington urged the importance of consideration of maintenance in the early stages of design—by adopting the right types of fittings, and Mr. Raphael asked for elucidation of the term "factor of safety" as applied to lighting installations.

Sir Duncan Wilson, in winding up the discussion, selected several points from the paper as of special consequence, namely the use of spectacles for very fine work, the value of some admission of daylight, if it could possibly be secured, and the problem of dealing with the smaller factories which were engaged on national work but might not come into the "vital" class.

Lighting Regulations for Factories

Draft statutory rules and orders, covering the requirements for lighting in factories, based on the Fifth Report of the Departmental Committee on this subject, have now been issued. These regulations are to apply to all factories in which persons are regularly employed for more than forty-eight hours per week. Forty days, from October 15 onwards, are allowed for objections and representations to be lodged, so that they should have the force of law in the near future.

The requirements are substantially those specified in the Fifth Report and are as follows:—

ILLUMINATION.

(*a*) The general illumination over those interior parts of the factory where persons are regularly employed shall be not less than 6 ft.c. measured in the horizontal plane at a level of 3 ft. above the floor:

Provided that in any such parts in which the mounting height of the light sources for general illumination necessarily exceeds 25 ft. measured from the floor or where the structure of the room prevents the uniform attainment of this standard, the general illumination at the said level shall be not less than 2 ft.c., and where work is actually being done the illumination shall not be less than 6 ft.c. or the greatest reasonably practicable illumination below 6 ft.c.

(*b*) The illumination over all other interior parts of the factory over which persons employed pass shall when and where a person is passing be not less than 0.5 ft.c. measured at floor level.

(*c*) The standards specified in this regulation shall be without prejudice to the provision of any additional illumination required to render the lighting sufficient and suitable for the nature of the work.

GLARE.

(*a*) Where any source of artificial light in the factory is less than 16 ft. above floor level, no part of the source or of the lighting fitting having a brightness greater than 10 c. per square inch shall be visible to persons whilst normally employed within 100 ft. of the source, except where the angle of elevation from the eye to the source or part of the fitting as the case may be exceeds 20°.

(*b*) Any local light, that is to say an artificial light designed to illuminate particularly the area or part of the area of work of a single operative or small group of operatives working near each other, shall be provided with a suitable shade of opaque material to prevent glare or with other effective means by which the light source is completely screened from the eyes of every person employed at a normal working place, or shall be so placed that no such person is exposed to glare therefrom.

(*c*) So far as reasonably practicable, arrangements shall be made, by suitable screening or placing or other effective method, to prevent discomfort or injury by the reflection of light from smooth or polished surfaces into the eyes of the worker.

SHADOWS.

Adequate measures shall be taken, so far as reasonably practicable, to prevent the formation of shadows which cause eyestrain or risk of accident to any person employed.

Under certain conditions exemptions may be granted by the Chief Inspector of Factories, and it is also specifically stated that the regulations shall not apply to certain classes of factories, amongst which are mentioned cement works, gas works, electrical stations, and factories devoted to such processes as the making of concrete and tar-macadam, iron smelting, rolling and forging, glass-blowing, tar distilling, petroleum refining, and the production of light sensitive photographic materials.

It will be observed that the regulations now presented in the main comprise recommendations made in the Fifth Report, in which numerical values are specified, though one provision requiring that walls, ceilings, partitions, etc., which are less than 20 ft. above floor level, shall be maintained light in colour, is not included. Apparently there were found to be administrative difficulties in giving effect to this recommendation.

A memorandum issued by the Ministry of Labour and National Service introducing these regulations (Ref. 803104/47) does, however, deal with qualitative aspects of lighting, and brings forward supplementary recommendations in regard to light-coloured surroundings, utilisation of natural lighting, etc.

This memorandum explains that the object of applying the regulations, firstly, to factories where more than forty-eight hours a week are worked is to secure priority of supplies for "long hour" factories, which are mainly those in which work of national importance is being conducted.

Reference is made to tabular data on electric lighting enabling the conditions ensuring maintenance of 6 ft.c. to be ascertained which were attached to the Fifth Report. In regard to expert advice, it is recalled that some firms have competent illuminating engineers of their own; but it is suggested that advice may also be sought from the Gas Lighting Committee of the Institution of Gas Engineers (1, Grosvenor-place, London, S.W.1), or from the local electric supply undertaking, or from the Joint Electric Lighting Committee (2, Savoy-hill, London, W.C.2).

The memorandum stresses the importance of relieving the effect of the black-out by light-coloured surrounding walls, ceilings, insides of roof shutters, etc., and the avoidance of glare and troublesome shadows.

The recommendations of the Fifth Report in regard to natural lighting are also summarised. The view expressed by the committee that the admission of some natural light during the day is very desirable is recalled, and likewise the suggestion that overhead windows to the extent of 12 per cent. of the floor area should be uncovered; whilst, in regard to side windows, it should be remembered that the upper portion of the window is far the more effective for illuminating the interior of the room, and therefore should, in the absence of any special reason to the contrary, be left unobscured.

Industrial Lighting and the Black Out

The opening meeting of the session of the I.E.S. Local Centre in Glasgow took place on October 16, when Mr. R. Maxted gave his Paper on "Industrial Lighting and the Black-out." The lecturer dealt with the difference between peace-time and war-time lighting installations, pointing out that the old standards of illumination were now inadequate under black-out conditions. No longer must we accept a lighting installation on its illumination level, but rather on its suitability, that is, its suitability as a lighting installation to permit the operatives to carry out their tasks for long hours under war-time conditions. This question of suitability was discussed at some length; particular attention was drawn to elimination of "glitter" by means of low brightness, large area sources such as the 80 watt tubular fluorescent lamp. Psychological aspects of a lighting installation were also discussed, and the lecturer illustrated several points by means of lantern slides.

A very full discussion then followed, amongst those taking part being Mr. A. W. Garret, Chief Inspector of Factories. Others joining in the discussion were: Mr. W. R. Gaythwaite, Mr. J. Galloway, Mr. J. Beck, Mr. F. A. Baumann, Mr. W. J. Jones, Mr. J. D. Mallet, Mr. E. J. Stewart, and Mr. M. W. Hime.

There was a good attendance at this meeting, some 100 members and visitors being present, and the audience included works engineers and executives from some of the largest works in the surrounding districts.

Literature on Lighting

(Abstracts of Recent Articles on Illumination and Photometry in the Technical Press)

(Continued from page 166, October, 1940.)

I.—GENERAL PHYSICS AND RADIATION.

208. Ultra-Violet and Electron Microscopy.

Prof. L. C. Martin. Nature, Vol. 146, No. 3696, p. 288, August, 1940.

Gives a summary of the development of visible light and ultra-violet microscopes and outlines the reasons for the limitation of resolving power. The theory and advantages of electron microscopes are also discussed. A. E. S.

II.—PHOTOMETRY.

209. Gauges for Checking Low Values of Illumination.

British Standard Specification BS/ARP 30. Revised version, September, 1940.

The chief modification relates to calibration. Gauges should be capable of checking one or more of the following values of illumination: 0.001, 0.002, 0.02, 0.1, and 0.2 ft.c. J. S. D.

210. An Improved High-Speed Recording Spectrophotometer.

George R. Harrison, Edward P. Bentley. J. Op. Soc. Amer., Vol. 30, pp. 290-4, July, 1940.

An automatic recording spectrophotometer is described which will trace absorption curves quickly from 2,000 A. to 10,000 A. A. E. S.

211. Production Colour Analysis of Kinescope (Television Cathode Ray Tube) Screens.

T. B. Perkins. J. Op. Soc. Amer., Vol. 30, pp. 295-6, July, 1940.

A three-colour process is employed for producing a variable degree of whiteness with which the test screen can be compared visually. The method is capable of good repetition and enables a standard of whiteness to be maintained in production. A. E. S.

212. Device Aids Testing of Street Lighting.

Kirk M. Reid and H. J. Chanon. El. World, 114, p. 278, July 27, 1940.

A description is given of a street lighting "evaluator," which, it is claimed, measures the "effectiveness" of a street lighting installation in terms of "net visibility." The apparatus is mounted on a motor-car, which enables it to be used easily in different positions in an installation. A full description is given of the apparatus and its method of use. S. S. B.

213. Evaluate Street Lighting With Chart.

Kirk M. Reid and H. J. Chanon. El. World, 114, p. 422, August 10, 1940.

The use of a chart, developed for use in conjunction with the street lighting evaluator designed by the authors, is described. From the road surface brightness, the brightness of the obstacle and a glare factor (determined automatically by the evaluator), the "net visibility" on the street can be derived. An example is worked out in the article. S. S. B.

214. A Contrast Meter for Photographic Papers.

C. A. Morrison. J. Op. Soc. Amer., Vol. 30, pp. 299-301, July, 1940.

A machine is described which automatically derives the curve of $\frac{d D}{d \log E}$ for a photographic paper from the curve connecting log Exposure and Density. The area contained by this curve, obtained by planimetry, is directly proportional to the contrast capacity Ω of the paper.

III.—SOURCES OF LIGHT.

215. Portable Lamps: Their Function and Selection.

Anon. Magazine of Light, IX., No. 6, pp. 18-23, August, 1940.

Suggestions with illustrations are made for the satisfactory use of nine different types of certified I.E.S. (America) portable lamps and of ten of a type not certified. C. A. M.

216. Fluorescent versus Incandescent Costs.

Anon. El. World, 114, p. 420, August 10, 1940.

A form of calculator (on the principle of the slide rule) is described, by means of which from the basic data (cost of energy, burning hours, and investment) the costs of lighting by fluorescent and incandescent lamps can be easily compared. An example is worked out. S. S. B.

IV.—LIGHTING EQUIPMENT.

217. Fixtures.

Anon. Magazine of Light, IX., No. 6, pp. 12-17, August, 1940.

Various patterns of ceiling fixtures and wall brackets are classified with diagrams, and recommendations for their installation are dealt with in detail. C. A. M.

218. Optimum Efficiency Conditions for White Luminescent Screens in Kinescopes (Television Cathode Ray Tubes).

H. W. Leverenz. J. Op. Soc. Amer., Vol. 30, pp. 309-315, July, 1940.

Spectral distribution curves of relative absorption and emission are given for zinc-cadmium sulphide phosphors and for white luminescent materials, as used in television screens. The most efficient screens have rather saturated hues, while the white emitting silicates suffer from loss of efficiency. The efficiency for white light production is greatest for the pair of spectral lines at 4,950 and 5,720. A. E. S.

V.—APPLICATIONS OF LIGHT.

219. Lighting and Eyesight.

G. V. Downer. Elect., 125, p. 149, September 20, 1940.

The author states that if lighting is of the appropriate quality, good visibility can be obtained with intensities considerably less than those at present considered necessary. He adopts daylight as a criterion. As the human eye is naturally adapted to daylight, it is preferable to use no more artificial lighting than necessary for comfortable seeing. He suggests that walls, ceilings, furniture, etc., should be as light as possible. C. A. M.

220. Black-Out and Daytime Conditions.

"Pharos." Elect., 125, p. 110, August 30, 1940.

A discussion is given for the lighting problems in war-time factory lighting resulting from the adoption of the Fifth Report of the Departmental Committee on Factory Lighting. Psychological aspects are considered, and recommendations are made on the use of fittings that will give some light upwards in order to simulate daylight as far as possible. C. A. M.

221. Contrast as an Aid to Lighting.

Anon. Elect., 124, p. 349, May 10, 1940.

The importance of contrast in lighting, brought into prominence by war-time lighting conditions, is discussed. The maximum brightness ratio which should be permitted for two contrasting surfaces is given as 10 to 1. C. A. M.

222. Home Lighting.

Anon. Magazine of Light, IX., No. 6, pp. 30-40, August, 1940.

Numerous illustrations are given of various activities about the home, with the appropriate type of lighting equipment and desirable illumination values. C. A. M.

223. Architectural Lighting Elements.

Anon. Magazine of Light, IX., No. 6, pp. 24-29, August, 1940.

Illustrations are given of the use of various architectural lighting features in home lighting. In addition, numerous suggestions with diagrams are given of concentrated direct, spread diffuse direct, and indirect lighting elements using normal or tubular lamps. C. A. M.

Revised B.S.I. Specifications

(a) Fluorescent and Phosphorescent Paint for A.R.P. Purposes (BS/ARP 18).

The most recently issued specification dealing with "Fluorescent and Phosphorescent Paint for A.R.P. Purposes" (superseding BS/ARP 18 of July, 1940) is a very comprehensive production. Of special interest is the method of defining the "unit of effective brightness" which, in the case of phosphorescent materials, is to be maintained after exposure to the activating source, for a specified period to be stated by the manufacturer.

The definition involves a principle of considerable scientific interest, and is adopted in order to deal with the complexities that arise when efforts are made to compare the performances of materials giving light of widely different colours. The position is fully explained in an Appendix D, in which the consequences of the Purkinje effect*, at the very low order of brightness here considered, are explained and illustrated. Of considerable interest from a photometric standpoint, also, is the description (Appendix B) of a brightness gauge to facilitate tests of brightnesses of the order of 0.1 units of effective brightness or less.

The new unit of effective brightness is explained in the specification in the following manner:—

> A unit of brightness in common use is the equivalent foot-candle which is defined as the brightness produced by an illumination of one foot-candle on a perfectly diffusing surface having a reflection factor of 100 per cent., comparisons of differently coloured surfaces being made at values of brightness sufficiently high to ensure that the observer's eye is in a state of light-adaptation. Owing to the fact that at low brightness the eye becomes progressively more and more blue-sensitive, the judging of the merits of differently-coloured luminescent paints on the basis of their equivalent foot-candles does not give a true measure of their relative practical usefulness. It is necessary, therefore, in measurements of coloured light made at brightnesses of less than one equivalent foot-candle, to define precisely the basis of such measurements. "The basis adopted by this Specification is visual comparison of any surface with a white diffusing surface illuminated by light from a tungsten filament lamp, operating at a colour temperature of 2,360 deg. K, the brightness of the white surface in equivalent foot-candles being defined as the product of its reflection-factor ρ and its illumination in foot-candles. This illumination is found by dividing the candle-power of the lamp (I) by the square of the distance of the lamp from the surface, in feet (d). The brightness of the white surface is therefore $\rho\frac{I}{d^2}$ equivalent foot-candles, and any coloured surface, judged by a normal observer to be equally bright, is said, for the purposes of this Specification, to have an effective brightness of $1000 \times \left(\rho\frac{I}{d^2}\right)$ units provided that the areas of the surfaces compared subtend an angle of at least five degrees at the observer's eye. It will be seen that the unit of effective brightness thus defined is equal to 0.001 equivalent foot-candles for light having a colour temperature of 2,360 deg. K.
>
> The unit of effective brightness may be stated in terms of other units, for light having a colour temperature of 2,360 deg. K. as follows:—1.0 unit of effective brightness is equal to 0.001 equivalent foot-candles, 0.001 foot-lambert, 0.001076 millilambert, and 0.000318 candles/sq. ft.

In its revised form the Specification occupied seventeen pages, as compared with the original ten. The increased size is accounted for mainly by the detailed and illustrated description of the brightness gauge now included in Appendix B and by the new Appendix D dealing with the Purkinje effect. This explanatory matter is aided by reproductions

*Readers may also be referred to explanatory article on this subject, "The Reds and the Greens," by Dr. J. W. T. Walsh, in our last issue (LIGHT AND LIGHTING, October, 1940, p. 162.)

of luminosity-factor curves for the light-adapted and the dark-adapted eye, and by a description of an experiment illustrating the difference between objective brightness and apparent brightness. It is extremely helpful.

(*b*) Gauges for Checking Low Values of Illumination (BS/ARP 30).

The new edition of the Specification for Gauges for "Checking Low Values of Illumination" is framed on very similar lines to BS/ARP 30 of January, 1940, which it supersedes.

The chief modification is in the series of brightnesses for which the gauges are to be calibrated, which are as follows:—0.001, 0.002, 0.02, 0.1, and 0.2 foot-candles. (When the illumination exceeds the latter value use should be made of illumination photometers such as enable measurements to be made in the customary manner.)

It will be noted that no distinction is now drawn between "nominal value" and "calibration value," which from the scientific standpoint is doubtless an improvement. It is now emphasised that the gauges are intended primarily for checking illuminations produced by sensibly white light, and that no attempt should be made to check a coloured illumination by means of a gauge in which a colour filter is interposed between the eye and the test plate.

The clause relating to brightness of the field of view has also been somewhat modified, the aim being that the brightness of the field of view shall not be less than that of the test plate when the illumination of the latter is 0.001 ft.c. (except for the effect of colour-matching filter, etc.).

I.E.S. Applications for Membership

Elections Pending

At the last meeting of the Illuminating Engineering Society on October 22 the names of the following applicants for membership were presented for the first time:—

CORPORATE MEMBERS:—

Birch, D. .....47, Vernon Avenue, Handsworth Wood, BIRMINGHAM, 20.

Keeling, H. A. .....75, Gower Road, Quinton, BIRMINGHAM, 32.

Pye, R. .....South View, Kirkby Lonsdale, WESTMORLAND.

Southern, A. .....16, Briarwood Grove, Wibsey, BRADFORD.

Wood, K. A. .....2, Primley Park Avenue, Alwoodley, LEEDS.

COUNTRY MEMBERS:—

Fraser, J. S. .....33, Lower Ford Street, COVENTRY.

Watkin, E. F. .....248, Daventry Road, COVENTRY.

Elections Completed

Applicants whose names had been presented at the previous meeting on October 8 ("Light and Lighting," October, 1940, p. 160) were again presented and were formally declared members of the Society. In addition, Transfers from Country Membership to Corporate Membership previously presented were (Trans. I.E.S., London, July, 1940, p. 88; "Light and Lighting," loc. cit.) duly confirmed.

Reviews of Books

Brass Chandelier: A Biography of Mr. R. H. Best, of Birmingham. By R. D. Best. (George Allen and Unwin, Ltd., London, 1940; pp. 251. 15s. net.)

This book is something out of the common. It is a record, prepared by his son, of the experiences of R. H. Best, a Birmingham manufacturer of lamps and chandeliers from 1840 to 1914. Records of trading results stand side by side with investigations of social conditions and efforts to improve popular education. There is a strong human element running through the whole. Of this we get a glimpse in the casual reference of Professor P. Sargant Florence, in his introduction to the "excellent ratting" at Best's Cambray works. The book is instructive in depicting the kind of robust characters produced in the past century—men whose limitations were balanced by extraordinary tenacity, enterprise, and energy, and a gift for improvisation. Best combined the function of designer, craftsman, salesman, and general organiser, but he was pre-eminently a craftsman. Some of his designs, such as the famous "Surprise" pendant, revealed much ingenuity. The ornamentation of some is no longer pleasing. But craftsmanship was his special care. As Professor Florence remarks, "Hideous as the design might be, it must be well executed, and woe to the workman who failed to attain his master's exacting standpoint." Best pursued his independent way from oil to gas and from gas to electricity. He had a horror of outside control, and preserved the status of a man owning and managing his own capital. Parts of the book are concerned with visits to Germany. His addresses contained criticisms of "they that tarry long at the wine" and warnings against Saturday nights ("they are often a stumbling block"). But he was impressed by the amenities of the German beer garden and the qualities of Bavarian beer ("one has to distinguish between Bavarian beer and the Bavarian *drinking* of beer"). His zeal for education was associated with enlightened views and, in dealing with the problem of continuation schools, favoured the view that the ideal education comprised a combination of study and practical work.

The Practical Electrician's Pocket Book. ("Electrical Trading," London, 1941; pp. 456; xliv. 3s. 4d. post free.)

Once more this compact annual publication makes its appearance, in spite of the stress of war. The present (forty-third) edition, in fact, seems to have been issued even more promptly than usual, and its forty-odd sections contain a great deal of condensed information. Quite a number of sections have been revised and rewritten, including those on rectifiers and measuring instruments, and a new section on radio servicing appears for the first time. In other respects efforts have been made to render the volume up to date. There is a very serviceable account, at the commencement of the book, of War-time Lighting Regulations, in which the chief reports and B.S.I. Specifications bearing on A.R.P. lighting problems are recorded, and of which useful extracts are made. There is also a brief summary of the contents of the Fifth Report of the Departmental Committee on Lighting in Factories. We are glad to observe that the section on lighting has been improved by the inclusion of notes on discharge lamps and the latest type of fluorescent tubular lamp, and we note that, in the section on photometry, a word or two has now been squeezed in bearing on photoelectric photometers. The data and tables have also been revised and rearranged for the benefit of students.

Electrical Wiring and Contracting (Vol. VI.). Edited by H. Marryat. (Sir Isaac Pitman and Sons, Ltd., London, 1940; pp. 213, figs. 60.)

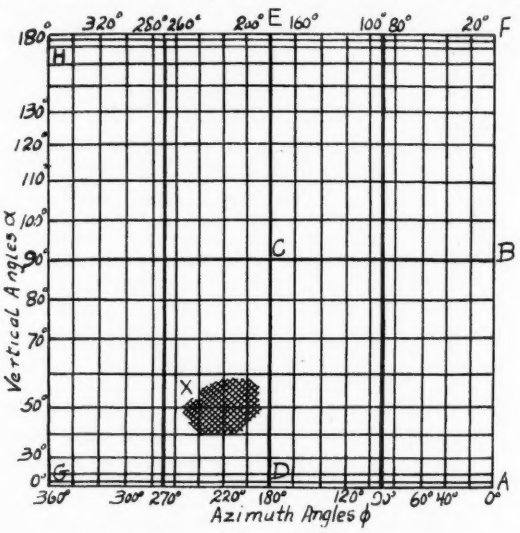
This volume, now issued in a revised condition, forms one of the series arranged to follow the scope of the City and Guilds syllabus. Of special interest is Section XXII., which deals with lamps and illumination and which occupies about 60 pages. Successive portions deal with fundamental ideas, radiation and vision, portable photometers, filament lamps, arc lamps, and discharge lamps, and applications of light in the home, office, and factory. The matter is brought up to date by references to the latest types of electric illuminants, and a brief account of war-time lighting is included. Other sections deal with electric lifts, and house and office telephones.

The Cylindrical Web for Isocandles

In a recent contribution to the *Transactions of the Illuminating Engineering Society (U.S.A.)*,* Dr. B. Monash recalls that the isocandle diagram, based on sinusoidal equal-area projection, was introduced by Frank Benford in 1925. It has proved specially useful for the representation of distribution of candle-power of asymmetric lighting units which, more and more, are being applied to street lighting.

Another device for the reproduction of a spherical diagram on a plane surface is the "isocylindrical web," using a cylindrical equal-area projection. If the evolution of a cylindrical area can be made into a plane for a whole sphere a web of straight rectangular lines is obtained, as here illustrated, where the lines corresponding to the longitudinal or azimuth angles are equidistant, whilst the distance of the lines of latitude or vertical angles a decreases proportional to the sine of these angles.

Dr. Monash remarks: "It is of a peculiar interest to illuminating engineers that the isocylindrical diagram was invented by Johannes Henricus Lambert,



Evolution of cylindrical area into web of straight lines relating to the whole sphere.

the father of photometry, in 1772, for quite another purpose. Lambert devised the isocylindrical diagram for map-making, and he was the first to enunciate the analytical laws of equal-area projection and to recognise its value for map-making. Lambert could not expect that 153 years after his invention of the web such a web would be found useful for representing photometric values."

Dr. Monash also points out that, in books available, the cylindrical diagram shows only one hemisphere, whereas the diagram illustrated above represents *the whole sphere*. The area *ABCD* shows the lower portion of the front hemisphere, and the area *BCEF* the upper portion. The area *DEHG* represents the whole rear hemisphere.

Thus the cylindrical diagram permits one to represent the whole sphere in one diagram, whilst with the onion diagram two separate diagrams are needed if the isocandles of the entire sphere are to be represented. This constitutes a definite advantage in many cases, especially when the lighting unit is asymmetric on both sides of the sphere.

The luminous flux escaping through any section x of the isocylindrical diagram (as shown above) may be obtained as follows:—

Let A = the area of the whole diagram.
x = the area of the hatched section.
4π = 12.57 the area of a sphere of unit radius,
I = the average isocandle luminous intensity of section x in candles.

Then the luminous flux escaping through section x is:—

$$F = \frac{12.57.x.I}{A} \text{ lumens.}$$

* April, 1940, p. 374.

Lighting to Conceal

An instance of ingenuity in lighting, recently reported by Mr. C. A. Atherton and recorded in the "Transactions" of the Illuminating Engineering Society (U.S.A.), illustrates how luminous surfaces may be utilised to conceal as well as to reveal.

In a large department store in Boston there is a basement shoe section. The ceiling is high but across it are a number of pipes which are not very decorative. The department was recently relighted and redecorated. In order to hide the pipes and still not to go to the expense of making a false ceiling, and also in order to maintain the volume of air upward overhead, there was built all round the store at the height of a normal ceiling a decorative cornice which stands out some inches from the walls on all sides. Above this cornice the walls, ceilings, pipes, and everything were painted a dead black. Below and including the cornice the store was decorated in light and pleasing pastel tints. The lighting consisted of fluorescent fixtures of the entirely down-light variety mounted at the level of the cornice. It is impossible to see past these lights into the dark ceiling. The impression is created that the room has a height of the cornice only. The hot air, however, rises into this dark, open space, where it is easily drawn off by the air-conditioning system.

Quality Industrial Lighting

There have been of late indications of a movement towards "artificial skylight" units, which have valuable qualities, e.g., in diminishing glare from highly polished surfaces, such as glittering, newly cast type. It is also recognised that for certain purposes, e.g., revealing defects in textile fabrics, oblique concentrated "uni-directional" light is desirable. Cases in which colour revealing is of importance and artificial daylight desirable may also be mentioned. But there are many other examples of the value of *quality* of light.

A considerable number of instances, revealed by illustrations, was recently presented in the I.E.S. "Lighting Review" (Australia). Many special applications of sources of large area and uniform low brightness are mentioned. In certain instances the combination of such a unit with a narrow directional beam is advised. Vapour-proof units, angle reflectors, and "special purpose projectors" find special applications. The use of luminous devices to assist the inspection of filled bottles in beverage factories and of polarised light to detect strains in glass are highly specialised processes.

Perhaps one of the most interesting devices described is the combination of two fluorescent tubular lamps, one green and one daylight, to facilitate the marking of steel with sharp tools as a guide for punching. It is the colour difference that brings out the marks. Neither green nor daylight alone will do.

"Adequacy" and "Suitability" of Factory Lighting

The problem of war-time industrial lighting, very ably discussed in Mr. Weston's recent paper before the Illuminating Engineering Society in London (see pp. 178-180), also formed the subject of a paper by Mr. R. Maxted, read before the Midland, North Midland, and Scottish I.E.S. local centres on October 11, 14, and 16.

After dwelling on the special circumstances leading to the issue of the Fifth Report (such as the fact that the period worked under artificial light is now so much greater than in normal circumstances), Mr. Maxted recalled that in official reports a distinction had been constantly drawn between "adequacy" and "suitability."

The former condition—which is interpreted as merely involving the provision of so many foot-candles—can now be satisfied very much more easily owing to the advances in the efficiency of illuminants and consequent diminution in the cost of light. But the importance of "suitability," which is much more difficult to define and express in regulations, is liable to be less understood and emphasised. Certain factors in suitability, such as the absence of glare, have been prescribed.

But there are many other conditions, some psychological, to be considered. Thus the adoption of light colours for surroundings, emphasised in the fifth report, is not merely beneficial in improving diffusion of light and softening shadows, but has an important effect in relieving the sense of oppression caused by complete darkness overhead. It is also valuable in another important direction, i.e., in diminishing troublesome glare and glitter from more or less shiny or polished material. All these advantages are secured in some degree wherever light sources of relatively extensive area and low brightness are introduced, and in this connection Mr. Maxted made a special plea for the recently introduced tubular fluorescent sources, giving a diffused light, approaching daylight in colour value.

In the course of his address Mr. Maxted showed a number of pictures of various processes lighted by extensive low-brightness units, and analysed the experience of operators in regard to eyestrain, fatigue, etc. In certain cases the introduction of the better lighting not only eliminated complaints of eyestrain, but enabled the workers to carry on with very much less general fatigue.

The processes in which greatest relief was experienced were those of a very fine and exacting nature, and included high precision machining and fitting, multiple coil winding, and the study of polished vernier scales. It was noteworthy that in certain cases where what was thought to be excellent lighting, which fully answered requirements, had been installed under peace conditions, complaints were raised under war conditions when daylight was excluded and long hours worked under artificial light.

Mr. Maxted made other good points. For example, in admitting the value of "supplementary local lighting" in many cases he urged that this specific illumination should be regarded as *the main lighting* and the general lighting as supplementary. He also drew attention to an obvious defect in some factories—the provision of very much better lighting for inspection than for the execution of work—a condition manifestly unjust to workers.

The experiences summarised in the paper lead to the consideration whether, by introducing very much better lighting conditions, a definite gain in quality and output of work can be secured and sustained—without the adverse results that arise when workers are called upon to maintain a special emergency effort beyond their normal powers. If it can be shown that better lighting (as regards both adequacy and suitability) results in production being raised to a permanently higher level without prejudicial results to workers, this would naturally be a result of outstanding importance at the present moment.

Contrast in Illuminating Engineering

Forthcoming I.E.S. Meeting 2.30 p.m. on December 10

We advise all I.E.S. members who can do so to make a special effort to attend the next I.E.S. general meeting to take place at 2.30 p.m., on December 10, at the E.L.M.A. Lighting Service Bureau. There is to be a discussion on "The Effects of Contrast in Illuminating Engineering."

This meeting is really a substitute for one which it was hoped to arrange in the Research Laboratories of the General Electric Company, Ltd., at Wembley. Owing to war conditions it was found impracticable to arrange this visit, but some members of the staff at Wembley have kindly undertaken instead to initiate the forthcoming discussion on Contrast, which will be illustrated by numerous and interesting demonstrations and experiments.

The various initial talks and demonstrations will be handled by Mr. J. M. Waldram, Mr. R. G. Hopkinson, and Mr. W. R. Stevens, and will follow approximately the following topics:—

I. *Contrast and Recognition.*—Seeing is more than perception of light, and recognition depends on contrast, shape or outline, and familiarity.

II. *Definition and Use of the term "Contrast."*

III. *Effects of Range of Brightness.*—Limits of perception by the eye. Effect of diminution in general brightness of scene. Portrayal of scenes having great brightness difference by means of photographs.

IV. *Variations in Contrast.*—Range of contrast depends on the manner in which objects are lighted; distribution of contrast may emphasise geometric solid form.

V. *Photographic Illustrations.*—Meaning of "Photographic Contrast." Representation photographs evoking sensations of contrast resembling those created by the actual scene.

VI. *Measures of Contrast.*—B_1/B_2; B_2-B_1/B_2; B_2-B_1 all measure stimulus, not sensation. Direct measurement of contrast impossible. Assessing contrast in terms of stimulus. Sensation curves.

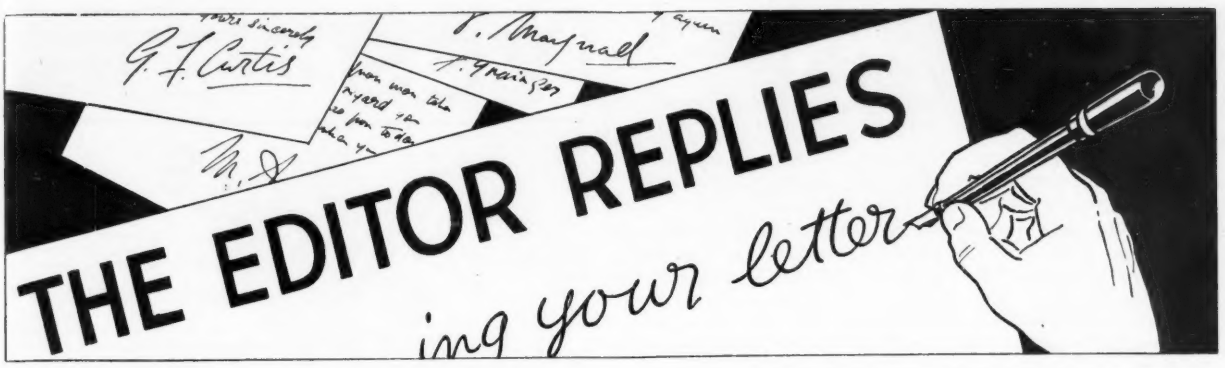
VII. *Practical Applications.*—War-time street lighting. Arranging for high contrast where most needed. Contrast in relation to camouflage. Inspection problems. Everyday experiences. Subtlety and complexity of "seeing."

Subsequently there will be an opportunity for general discussion on this fascinating subject.

Obituary

Dr. C. H. Merz.

We record with great regret the death, on October 15, of Dr. C. H. Merz, who was associated with the firm of Merz and McLellan, consulting engineers. Dr. Merz had gained a position of great eminence in the electrical industry. He was prominently identified with electric supply, both in connection with the area operated by the North Eastern Electric Supply Co. and the County of London Electric Supply Co. and its various offshoots, and acted as consulting engineer to many undertakings and public bodies abroad. He was responsible for many important electrification schemes, including railway electrification, on which he read numerous papers. He was a Vice-President of the Institution of Electrical Engineers. Although not taking an active part in the details of its work, he had been, for a number of years, a valued member of the Illuminating Engineering Society.



Our remarks on the **protection of window glass** have led to inquiries whether there is really any advantage in leaving windows open (or some of them) during periods of danger. It seems only common sense to assume so as the shock is associated with a definite air-movement. The writer was strongly advised to open all windows on one recent occasion when a time bomb was being exploded in the vicinity. At the same time there appear to be some who are sceptical, and one seems to recall a description of A.R.P. drill at a public school where the prefects went round *closing* windows when a warning was received (possibly as a protection against gas). Those interested in this problem may care to know that a **demonstration** of methods of protecting windows of factories is being arranged at the Home Office Industrial Museum (Horseferry-road, Westminster).

In response to inquiries, we have ascertained, on good authority, that there has been no prohibition of the **"Open" signs** for shops, etc. (Par. 40 in the Lighting (Restrictions) Order), though the prohibition does, apparently, extend to display lighting (Par. 41). It should be remembered, however, that according to Par. 44 in the Order all such signs must be extinguished on receipt of an air-raid warning, so that, under the conditions prevailing in London recently, not a great deal of use can be made of this permission!

A reader who has been summoned (and fined), on the ground that the **curtains** at his home allow **light to escape,** protests that they were considered perfectly satisfactory last winter, and in his opinion the transmitted light and brightness are negligible. He urges the need for some standard and method of test.

This problem is a difficult one. The judgment of those patrolling the streets after dark is rather unpredictable. A curtain that passes inspection under normal conditions may give offence on an exceptionally dark night. Much may be ascribed to the **extreme sensitiveness** and oddities of the **fully dark adapted eye** which can perceive the faintest glimmer; in fact, one may doubt whether *any fabric* is completely opaque in such circumstances.

There is also the danger that the vigilant eye may, on comparatively light nights, mistake reflected for transmitted light. The writer recalls experience of a green curtain that was said to offend, though those emerging from the house into the darkness saw only complete obscurity. Not only was the curtain a thick one, but the lights in the hall behind it were so masked as to make the use of torches expedient. The warden was surprised by the obscurity within, but continued to assert that there was "a glow—a kind of glow" without. One had a suspicion that our old friend Purkinje was at work—though it was quite impossible to explain this in rainy darkness punctuated by gunfire!

Seriously, in common fairness to the householder, some **standard of brightness** seems called for. There would be no serious difficulty in contriving a rough gauge (similar to that designed for the inspection of the brightness of luminous signs). The difficulty—which has proved fatal in other similar cases—is to ensure its being generally adopted.

Presumably it would be agreed that the maximum value assigned for war time street lighting (in practice running up to 0.0004 e.f.c.) would be innocuous. But as we are here dealing with vertical and not horizontal surfaces a somewhat higher limit might be agreed, such as the new "unit of effective brightness," equal to 0.001 e.f.c. This is also the lowest value specified in the specification for gauges (BS/ARP 30). No doubt householders would still be warned that complete opacity was the ideal, but a prosecution would not be considered unless it was known that 0.001 e.f.c. had been materially exceeded.

I am afraid that I must also confirm that **the use of torches and hand lamps** out of doors is illegal during an air raid. This is explicitly stated in Par. 50 of the Lighting Restrictions Order. This fact enhances the value of war time street lighting, but certainly makes it hard for those caught in unlighted streets. One wonders whether some special form of torch, of low luminosity and complying in design with a B.S.I. specification, could not be permitted.

Readers will be interested in the **simple form of light lock** of which particulars have been sent us by Mr. W. Hime, described in this issue (p. 177). The design departs somewhat from the standard type, but has the merit of economising space, an important consideration in the case of small shops. The chief drawback that might be urged is against such automatic devices is that they might get jammed in the event of a sudden rush of people, but experience seems to show that in practice, under present conditions, this is not very likely to arise.

Readers interested in the idea of **a visible raid warning** sign, mentioned in our last issue, draw attention to a suggestion in the Press that lamps used to afford war time street lighting should be caused to "flicker." This would not be very easy to arrange with electric lamps, and surely most difficult in the case of gas lamps. Other objections are that such a sign would be indistinguishable by day and not very readily perceptible at night, and that one would prefer that synthetic star light did not resemble natural stars by continuous twinkling as well as faintness. Neon signs of low luminosity but distinctive colour, screened from observation from above, might be preferable.

I have been asked to state the approximate **brightness of the moon.** This is of the order of 1,000 e.f.c., or rather more than two candles per sq. in. This brightness is not very far removed from that of a candle flame, and has been suggested as a reasonable standard for the limiting brightness of fittings used for interior lighting. This figure was mentioned in an article in *The Illuminating Engineer* for April, 1917 (p. 113), to which those interested in relation between the value of moonlight and direct sunlight may be referred.

The Illuminating Engineering Society (U.S.A.)

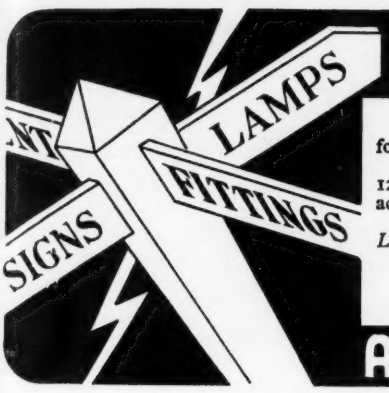
Notes on Transactions (September, 1940)

NEWS: *Certified Lighting Fittings,* approved by the American Lighting Equipment Association, and complying with descriptive specifications, are now being introduced. Such fittings will be identified by an ALEA certification tag, testifying that they conform to the ALEA Advisory Board's conception of proper design and quality. Samples will be submitted to the electrical testing laboratories for testing and inspection. The editorial note, " Is 'Illuminating Engineering' the Right Description?" is quoted from *Light and Lighting* (July, 1940). The problem of floodlighting walls of high buildings that have no set-back has been a difficulty. The tower of one of the Edison Company's buildings in Chicago has been treated by means of a special fluorescent lighting system, long vertical reflector channels or " tracks " mounted 3 ft. from the wall being used. Seven-foot sections, each containing two sets of 30-w. 3 ft. tubes, yielding white light, are used. A new problem arising in the use of walls of glass block construction is the compensation, in air conditioning, for the solar heat transmitted through these glass walls. Tests on model structures are being conducted by the American Society of Heating and Ventilating Engineers. In designing floodlighting installations for sports areas a new method of " sighting up " by the aid of coloured lenses has been devised. The process is assisted by a steel strap clamp, fitting over the face and centre of the floodlight reflector. This is furnished with a hole and red spot, which have to be brought into alignment. It is announced that the Massachusetts State Department of Education has planned a University Extension Course on Fluorescent Lighting. A series of sixteen lectures on various aspects of the subject, to be delivered on successive Fridays, has been arranged.

CONTRIBUTIONS: *Fluorescent Lamp Applications in the Home,* by M. Fahsbender and R. G. Slauer. The various advantages and drawbacks of fluorescent lighting units in the home are discussed. Daylight quality of light is acceptable and blending with other sources, if skilfully done, is effective. The coolness is a merit in connection with " built-in " lighting. Numerous special devices, portable lamps, under-cabinet lighting, curtain illumination, etc., are illustrated. Stroboscopic effect is, in general, of small moment—as is shown, in the main, by the experience of ping-pong players. The hum or noise inherent in the use of transformers is less than that experienced with electric clocks or refrigerators. Slow starting after switching on is some drawback, and likewise radio interference and initial cost.

Relighting a Large Industry, by J. M. Smith. Experiences in the planning and execution of a relighting programme of the General Electric Company (U.S.A.) are summarised. In 1935 the Works Illumination Advisory Committee, consisting of illuminating engineers from the various branches, was revived. The committee acted in an advisory capacity, the improvements being executed by the plant engineers, who are kept abreast of improvements by means of conferences, etc. Visits were made to all important works and the results debated in conference. During 1937-38 about one and a quarter million of square feet of floor space in various works were relighted, and in 1938-39 another 900,000. In general an illumination of 30 ft.c. is recommended in all manufacturing areas. In offices 30-50 ft.c. and in drawing offices 40-90 ft.c. are being advised. With such illuminations the effect of radiant heat is a consideration. In this connection the fluorescent lamp is helpful, and in several installations using such lamps 75-100 ft.c. is provided. Numerous illustrations of relighted interiors are shown. Indirect and semi-indirect systems, and in some cases fluorescent units in troughs in the ceiling, are widely utilised.

Some Effects of Illumination on Reading Efficiency, by M. Luckiesh and F. K. Moss. Eye-movements and processes involved in reading, before and after one hour's operation under various illuminations, were studied. Data include " electromyograms," i.e., wave-forms of currents arising from eye-movements, and observations of time required to read a single line of print. Diagrams are presented showing that the latter at 100 ft.c. is 82 per cent. of the value characteristic of 1 ft.c.



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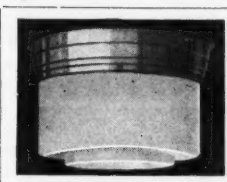

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